H&H Support for Environmental Restoration: Research, Guidance, and Training Needs

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Abstract

It would be beneficial for the Corps of Engineers to develop a comprehensive program (including research, guidance, and training) for H&H support of environmental restoration. Although the Corps has taken on the mission area of environmental restoration, little or no new guidance has been published for H&H design. Hydraulic engineers are being asked to evaluate and design a wide array of new techniques; many of these have had no engineering evaluation, or have only artists' sketches as design documentation. Although the Corps has invested heavily in developing tools and training for hydraulic engineers in the flood damage reduction mission area, there has been no concomitant effort for the engineering aspects of environmental restoration. It would be helpful to the districts for the Corps to prioritize and address research needs, disseminate research results as guidance, and develop a training program that gives hydraulic engineers the necessary tools to tackle these projects. Interdisciplinary training and interagency cooperation would further this effort. This paper will discuss support needs in the area of stream restoration and watershed rehabilitation, and outline steps that the Corps could take (based on the author's experience) to become a leader in this new and challenging mission area.

Introduction

The Corps has taken on an extensive, challenging mission area that makes new demands on hydraulic engineers. Stream and watershed restoration projects often require the application of our traditional skills in non-traditional ways and the use of techniques for which no formal guidance exists. The planning and design of restoration projects could be made more effective and efficient if a comprehensive program of research, guidance, and training were implemented to support the hydraulic engineer's role in stream and watershed restoration. This paper discusses support needs and outlines steps that the Corps could take to become a leader in this mission area.

Watershed restoration projects versus traditional flood control projects

The differences. Stream and watershed restoration projects are often different from "traditional" engineering projects in a number of ways:

- goals and criteria are often less well defined
- an interdisciplinary approach is necessary; engineers must work closely with biologists and ecologists
- the multiplicity of variables in a natural system may make the driving processes more difficult to understand, the system's response less predictable, and success more difficult to evaluate
- it may be more acceptable to take risks (that is, a certain level of failure may be acceptable
- there may be significant disagreement among the team members on the underlying processes occurring in the watershed
- there is often no common team understanding of the role of the hydraulic engineer role on the project; in fact, the project team may not be aware that there is any need for a hydraulic engineer on the project.
- there is often less agreement on engineering methodology: what data should be collected, what survey data is necessary, what analyses should be performed.
- there may be significant distrust, within the technical team itself, of the engineer's methods and motives
- there is often little or no design guidance for proposed restoration measures
- there may be significant unresolved questions in analysis and design.

The similarities. Traditional hydraulic engineering projects often involve working with other disciplines or working on a small scale. Streambank protection projects, for instance, are often small-scale projects where risk to life and limb is not a factor, so that a higher level of risk in design is acceptable. New techniques, low-cost methods, or demonstration projects may be more readily incorporated into the design. Hydraulic engineers have normally worked on interdisciplinary teams with economists, real estate specialists, cost estimators, and civil, geotechnical, and structural engineers. In almost any engineering project, the wishes of local residents, local sponsors, and political representatives have to be understood and taken into consideration. The foregoing examples show that engineers have a track record of working on small-scale projects, accepting higher risks where appropriate, and of working with other disciplines.

Strengths that the Corps brings to the mission of stream and watershed restoration

Hydraulic engineering capability. The Corps of Engineers is an acknowledged leader in the field of hydraulic engineering. We have more hydraulic engineers than any other agency, and we have an enviable array of tools (including 1-D, 2-D, 3-D

and physical models) at our disposal. Stream and watershed restoration projects involve manipulation of water, and in this area we have an unparalleled breadth and depth of experience.

River engineering capability. The Corps is one of the few agencies to combine the fields of hydraulic engineering, fluvial geomorphology, and sedimentation to form the specialty area of "river engineering." For decades, the Corps has performed ground-breaking research into river behavior, and continues to work with the top geomorphologists and engineers in the world to improve our understanding of how channels and watersheds perform. This multi-faceted approach, which combines the strengths of several disciplines, is essential to successful restoration efforts.

Successful large-scale watershed restoration projects. The Corps has halted system-wide instability in watersheds such as the Gehring Drain (Nebraska) and the Demonstration Erosion Control Project (DEC) in northern Mississippi. The DEC is especially noteworthy, as it is an ongoing project, with excellent baseline data, continued monitoring, and interagency cooperation. It comprises 16 watersheds, totaling 2300 square miles, making it one of the largest watershed restoration projects in the nation. Sediment yields from the DEC watersheds have been reduced dramatically. The understanding of channel and watershed processes developed by the Corps is the foundation for the success of these projects.

Presence of multiple disciplines within the Corps. Corps district staff includes all the disciplines necessary to the interdisciplinary team on restoration projects, and is especially strong in the environmental and biological sciences. The Corps has placed a significant emphasis on environmental science, with state-of-the-art modeling capabilities and research conducted by the ERDC Environmental Laboratory at WES. This in-house environmental expertise is necessary to the planning and design of successful environmental restoration projects.

National research laboratories and facilities. The research capabilities of the Corps play a key element in its leadership in the hydraulic engineering field. The research, training, and software development conducted by ERDC and HEC give working-level engineers the tools they need. The expertise of the engineers and scientists at these facilities may not be required for everyday engineering tasks, but is available and appreciated for unusual and complex problems. The expertise and capabilities of the research facilities give the Corps flexibility to handle almost any task.

Other factors. The following is a brief list of other factors that make the Corps well suited for the mission of stream and watershed restoration:

- capability of handling projects of any size or scope, from small streambank protection projects to the Florida Everglades
- national perspective
- capability of handling all phases of project, from planning through construction

- districts organized by watershed boundaries
- 41 districts (doing similar work) can provide broad experience
- Division and Headquarters offices can provide support at regional and national levels.

Major obstacles to our success in environmental restoration. The two most important obstacles to successful H&H support for environmental restoration are:

1. Lack of adequate tools, guidance, and training that address the hydraulic engineering aspects of stream and watershed restoration projects.
2. Lack of a shared understanding of watershed processes (and the role of the hydraulic engineer) by the rest of the interdisciplinary team.

Recommendations to improve H&H support for environmental restoration

1. **Establish a comprehensive program of research, guidance, and training.** Hydraulic engineers at the district level need a comprehensive program focused on the engineering analysis and design of stream and watershed restoration projects. This program should use input from the field to develop a program of research, guidance, and training that will streamline, standardize, and improve our capability to handle restoration projects of varying sizes and complexity.
    a. **Research.** Establish a road map for restoration research, using input from across the Corps, and come up with a plan that will address all major needs within a reasonable timeframe. Determine the highest priority topics and allocate sufficient funding to investigate them and to deliver a product that the working-level engineer can use. Often the first research product would be a critical evaluation of current practices with guidance on their application (for example, a review of Newbury's design criteria for rock riffles.) This would be helpful for all topics, and might be sufficient for many. Others would require additional research, or preparation of design tools or software. For example, equations developed to compute Manning n values for vegetation (Copeland, 2000, and Fischenich, 2000) are mathematically complex, and would probably used more widely if there were supporting software and plant information.
    b. **Dissemination of "professional consensus" to the field and to our customers.** River engineering is a specialized field. Design and analysis methods that are considered axiomatic by professionals in the field are often unknown to others (even experienced hydraulic engineers). As a result, one paramount need for many topics is establishing the consensus of professional opinion and disseminating it to the field. This is an instance where research does not have to be "basic" to be useful. An investigation of the state of the science for various topics, a critical evaluation of what is known and not known, and a technical writeup that can be used to educate the entire project delivery team are enormously useful research products, and can be

integrated into guidance and training documents. One worthy goal would be ensuring that hydraulic engineers throughout the Corps have the same basic understanding of river engineering precepts that our best river engineers have: this alone could take quite a bit of effort, but would result in restoration projects being handled more uniformly throughout the Corps.

c. **Guidance.** There is no formal guidance that addresses how to design engineering features that meet ecological goals. Although much research has been published (by the Corps and others), there are many discrepancies in approach. Formal guidance puts a corporate seal of approval on certain analysis and design methods, and disseminates peer-reviewed expertise to the field. This would assist the working-level engineer in selecting techniques and analysis methods, and would give the Corps a uniform stance on technical issues. The development of guidance for the hydraulic engineering aspects of environmental restoration projects is a critical need.

d. **Training.** Training for hydraulic engineers in ecosystem restoration was identified as the highest priority training need in a Corps-wide survey of H&H Sections (Task Force for Assessment of H&H Capabilities in USACE, 2001.) Training gets the results of research and guidance out to the field, and teaches engineers how to use the tools that have been developed. Central funding for training in H&H support for ecosystem restoration projects might be desirable, and might be equitable considering the training efforts in other functional areas.

2. **Train the entire team.** One of the major barriers to our success in ecosystem restoration is the lack of a common understanding (among the team members) of watershed processes, analytical tools, and potential hazards. It is not sufficient to train within our own discipline of H&H; it is essential that the entire interdisciplinary team have a basic understanding of H&H processes and tools. (The converse is that hydraulic engineers must understand ecological goals, processes, and tools.) A common understanding of processes helps the team work smoothly and come up with similar objectives and project alternatives. The special expertise that hydraulic engineers bring to restoration projects is useless if it cannot be communicated to the rest of the team. My experience in almost 20 years of working on restoration projects is that the lack of a shared understanding of watershed processes and engineering constraints can cause major problems on projects. Disagreement on processes leads to disagreement on restoration measures. This can cause major rifts within the projects team, wasted time, and in the worst cases, stalled or cancelled projects. In order to meet this need, ERDC-CHL is currently considering developing a short course for planners, project managers, regulators, ecologists, and engineers, that will outline stream and watershed processes at the “intelligent layperson” level so that the entire team has a common understanding of H&H processes involved in ecosystem restoration projects. This is a limited initiative by ERDC-CHL to meet an

evident need, but should be carried out in a broader way as part of a comprehensive program for H&H support of ecosystem restoration.

3. **Set priorities and develop an overall plan with an end-point in the foreseeable future.** Once a comprehensive program of research and guidance needs has been identified, a strategy should be developed for completing a reasonable portion of this program within a set timeframe. Priorities must be set within the work plan, with the understanding that the highest priority needs will be tackled first, completed, and then the next set of priorities will be addressed.
4. **Work with other agencies to make our dollars go further, and to accommodate specialized needs, such as arid regions or ice engineering.** In order to use our limited resources more wisely, the Corps should make an increased effort to coordinate and partner with other entities. This makes sense for specialized areas, such as arid regions and ice engineering, where entities with specialized expertise could contribute greatly to our efforts. It also applies to collaboration (or at a minimum, coordination) with other federal agencies doing similar work: USGS, Bureau of Reclamation, EPA, NOAA, NRCS, FHA, etc. Any shared objectives that we can find with other agencies will enable us to leverage our dollars, save money, or perhaps to cover an area that we otherwise might have to forgo.
5. **Develop a mechanism for sharing lessons learned.** Ecosystem restoration is a new and rapidly evolving area, where the "state of the art" is constantly changing. With 41 districts working on a wide array of projects, one of the Corps' greatest potential assets is the experience of its own engineers. However, currently there is no easy way for an engineer in one district to take advantage of the experience of other Corps districts.

What's next?

In order for the Corps to "be all it can be" in the arena of H&H support for ecosystem restoration, commitment and leadership is required at a high level. Although many activities are being completed by individual researchers and engineers, some crucial items can only be carried out at the headquarters level. These include:

- development and execution of a comprehensive program for H&H support of ecosystem restoration
- interaction with other functional areas within the Corps (in particular, Planning and Regulatory) to define the role of H&H in ecosystem restoration activities
- coordination with other federal agencies to incorporate H&H involvement in interagency restoration research, training, and guidance, and to coordinate Corps activities with outside efforts.

Summary and conclusions

The Corps has all the ingredients for success in hydraulic engineering support for ecosystem restoration. The excellent work that is being done in many locations

nationwide could be used as a foundation to greatly increase our accomplishments. For the reasons outlined in this paper, the Corps could increase its leadership role in H&H support for stream and watershed restoration, and could increase its contribution to the state of knowledge in this field. Interdisciplinary training for the project team (in H&H processes) could also increase teamwork and customer satisfaction.

References

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